Enhance System Test & Evaluation from development to battlefield via Technology Integration with Maintenance Test and Training

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AGENDA

➔ Impetus
➔ Technology Overview
➔ Plan and recommendation

Enhance System Test & Evaluation from development to battlefield via Technology Integration with Maintenance Test and Training

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USATA Advanced Technology Office

❑ **Over ten years of successful R&D programs aimed at the toughest, but highest leverage segments of maintenance technologies:**
  - ➡ **Integrated diagnostics -- development tool**
    - ✓ **Design for diagnoseability and testability**
    - ✓ **Reduced TPS cost and runtime**
  - ➡ **Prognostics framework -- system design tool**

❑ **Underlying "Core Technology" advancements support Test and Diagnostic Technology**

Developmental and Operational Tests & Evaluations Issues

❏ **No integrated system-level developmental and operational test and evaluation mechanisms**

❏ **No planned database to track the developmental test and evaluation data to support operational test and evaluation**

❏ **No onboard system capable of evaluating the health of weapon systems for battlefield decisions and logistics planning**

❏ **High no evidence of failure (NEOF), maintenance training cost, and maintenance costs**

❏ **Traceability from performance parameters to end design is not structured**

DT/OT Problems for Military Systems are Generic Across the Services and Systemic of the Way We DO BUSINESS. Major Changes are Required!

System Battle Damage Assessment (BDA), Logistics, & Training Issues

❏ No Technical Manual (TM) for BDA and no or inadequate system-level interactive electronic TM
❏ No formal integration of IETM and Training Materials
❏ No planned database to track BDA data to support development of the BDA and Repair (BDAR) TM
❏ No onboard system capable of evaluating the health of weapon systems for battlefield damage assessment and associated logistics requirements
❏ High cost BDA and high repair training cost
❏ Traceability from performance parameters to end design is not structured to support BDA
❏ WRM are based on peacetime requirements

BDAR Problems for Military Systems are Generic Across the Services and Systemic of the Way We DO BUSINESS. Major Changes are Required!

Maintenance Test Issues/problems

❏ No integrated system diagnostics/prognostics
❏ No onboard system capable of evaluating the health of weapon systems for battlefield decisions and logistics planning
❏ High no evidence of failure (NEOF), maintenance training cost, and maintenance costs
❏ High mean time to repair and low system mission readiness
❏ Time consuming troubleshooting and inadequate IETMs and high cost TPS development
❏ Time consuming parts ordering and high error rate

Maintenance Test Issues for Military Systems are Generic Across the Services and Systemic of the Way We DO BUSINESS. Major Changes are Required!

The Time for Dramatic Changes is NOW!!

❏ **Software Technology has been revolutionized in the past decade:**
   Object Oriented Programming, Client-Server Software, True Open Architecture, XML, Integrated Data Environments, Platform Independent Software, Internet and Intranet communications, Visual Programming, OLE,DLL, Active-X, etc.

❏ **Most military software is antiquated, and will be updated over the next decade to take advantage of these advances**

❏ **OPPORTUNITY EXISTS NOW TO CHANGE FUNDAMENTAL BUSINESS CONCEPTS**

❏ **Unfortunately most automation programs are automating the same technology/business process**

The OPPORTUNITY for Re-Defining Fundamental practices must not be MISSED!
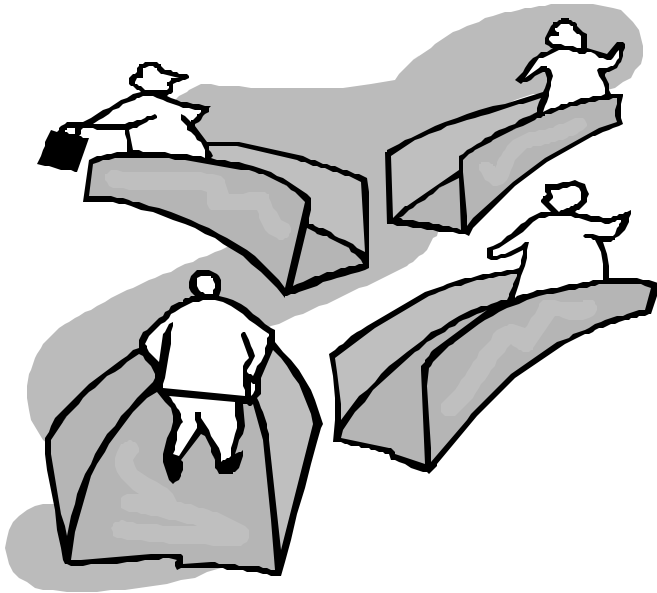
The time and the state of technology may be right for T&E, Logistics, and Training communities to stop going in different directions…

…and converge on a common, information-driven approach to test requirements

Test Domain
Does System/Item Meet Specified Performance Requirements?

Test & Evaluation

Uncertain Item Ever Performed Properly

- Will system perform as specified?
- If not, Why not?
- How do I fix it?

- Engineering Analysis of Design
- Test of Lower Level Performance Parameters
- Delineation and Synthesis of Functional Elements
- Measurement Science: sensors & instrumentation, Data Acquisition
- Early design–based simulations

Maintenance Test

Certain Item Once Performed Properly

- Does system now perform as specified?
- If not, Why not?
- How do I fix it?

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Combine T&E and Training, with the Maintenance test diagnostic knowledge database to provide an _integrated_ field training package for BDAR and enhance Logistics Supportability through Interoperability.

Embedded Diagnostics
Design Solutions

Test and Evaluation
(DT/OT) Solutions

Systems

CAD Data

Performance Monitoring
& BIT Strategy

Testability
Improvements

Subsystems

Boards

TEST
CAPABILITY

Performance Monitoring and Built-in Test
Gathers Status Information

Diagnostic Software
Interprets Information

Test Software
Gathers Information

Model-Based
Diagnostician™

TEST &
EVALUATION

Test and Evaluation Data
Management and Networking

Developmental
Test

Operational
Test

HIERARCHICALLY
LINKED MODEL BASES

SYSTEM
BOX
BOARD
CIRCUIT

System Level

Box Level

Board Level

Circuit Level

MAINTENANCE
TEST

"Umbilical Cord" Testers
Data Bus Interrogation

VXI Field Testers

Depot Test Equipment

Portable Maintenance Aids
Electronic Tech Manuals

Highly Mobile Test
Equipment

Maintenance Test &
Support Solutions

✓ _T&E_
✓ Training
✓ Logistics
Supportability

COMMON TEST DOMAIN FOR MAINTENANCE AND T&E

❏ **Engineering Analysis of system's design**
❏ **Test of lower level performance parameters**
❏ **Measurement Science: Sensors, instrumentation, and data acquisition**
❏ **Early design –based simulations**
❏ **Delineation and synthesis of functional elements**
❏ **Traceability from performance parameters to end design to being supported in the field**

How do we more effectively and efficiently leverage off these common elements ?
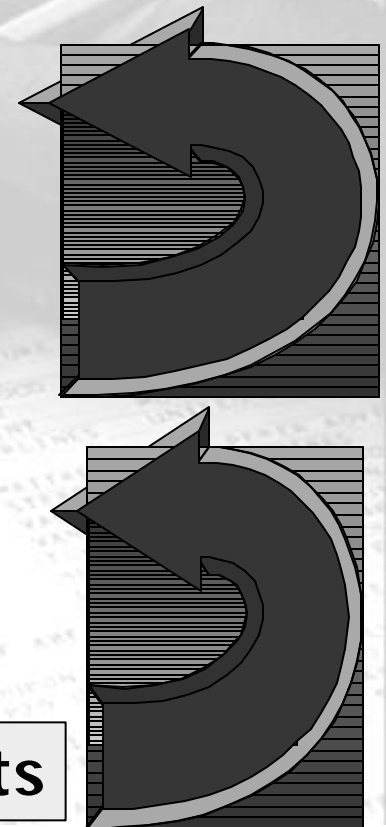
Imagine, if you will…
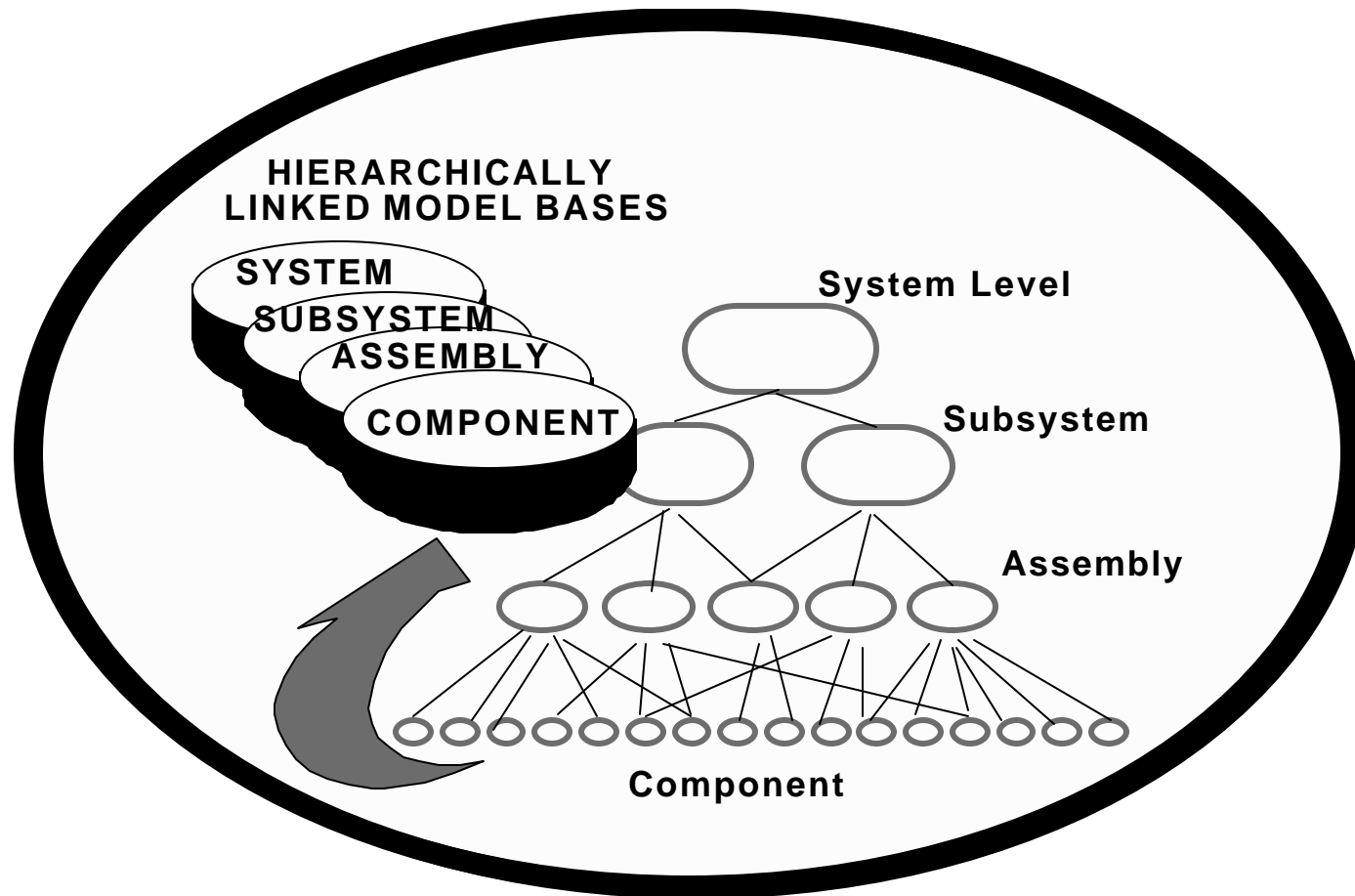
…A design-based model…

… that correlates design elements to system functions to mission performance…

Mission Performance Parameters

System/Item Functions

Hardware/Software Design Elements

… and includes all test/diagnostic characteristics: testability, performance monitoring, built-in test, sensors, etc…

Systems

CAD Data

Performance Monitoring & BIT Strategy

Testability Improvements

Subsystems

Boards

TEST CAPABILITY

Performance Monitoring and Built-in Test Gathers Status Information

Diagnostic Software Interprets Information

Test Software Gathers Information

Model-Based Diagnostician™

HIERARCHICALLY LINKED MODEL BASES
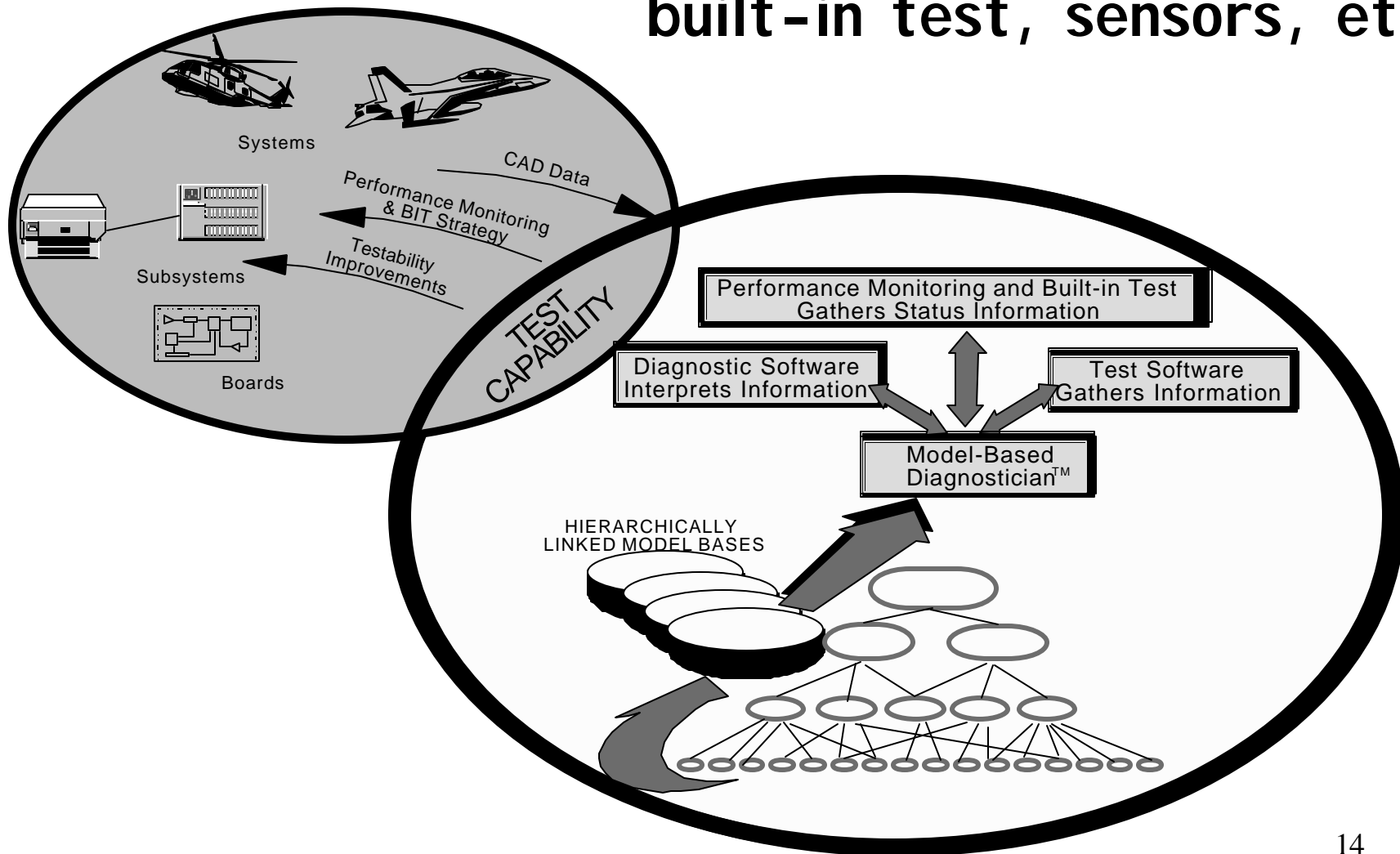
And gives us the capability to track performance over time....

Synthesis

Analysis
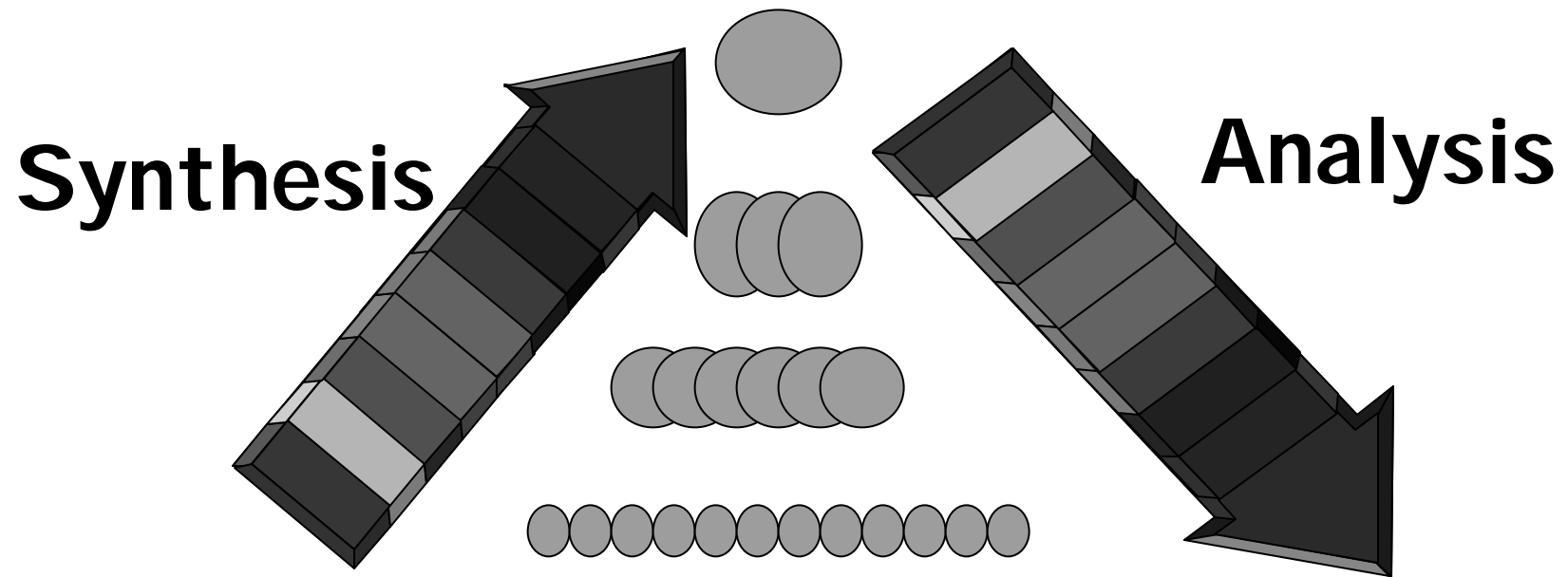
... and trace performance issues to fundamental "principals of design" ...

…and, at the same time, generates the deployed diagnostic/prognostic and health management capability…

Performance Monitoring and Built-in Test
Gathers Status Information

Diagnostic Software
Interprets Information

Test Software
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Maintenance Test &
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Data Bus Interrogation

VXI Field Testers

Depot Test Equipment

Portable Maintenance Aids
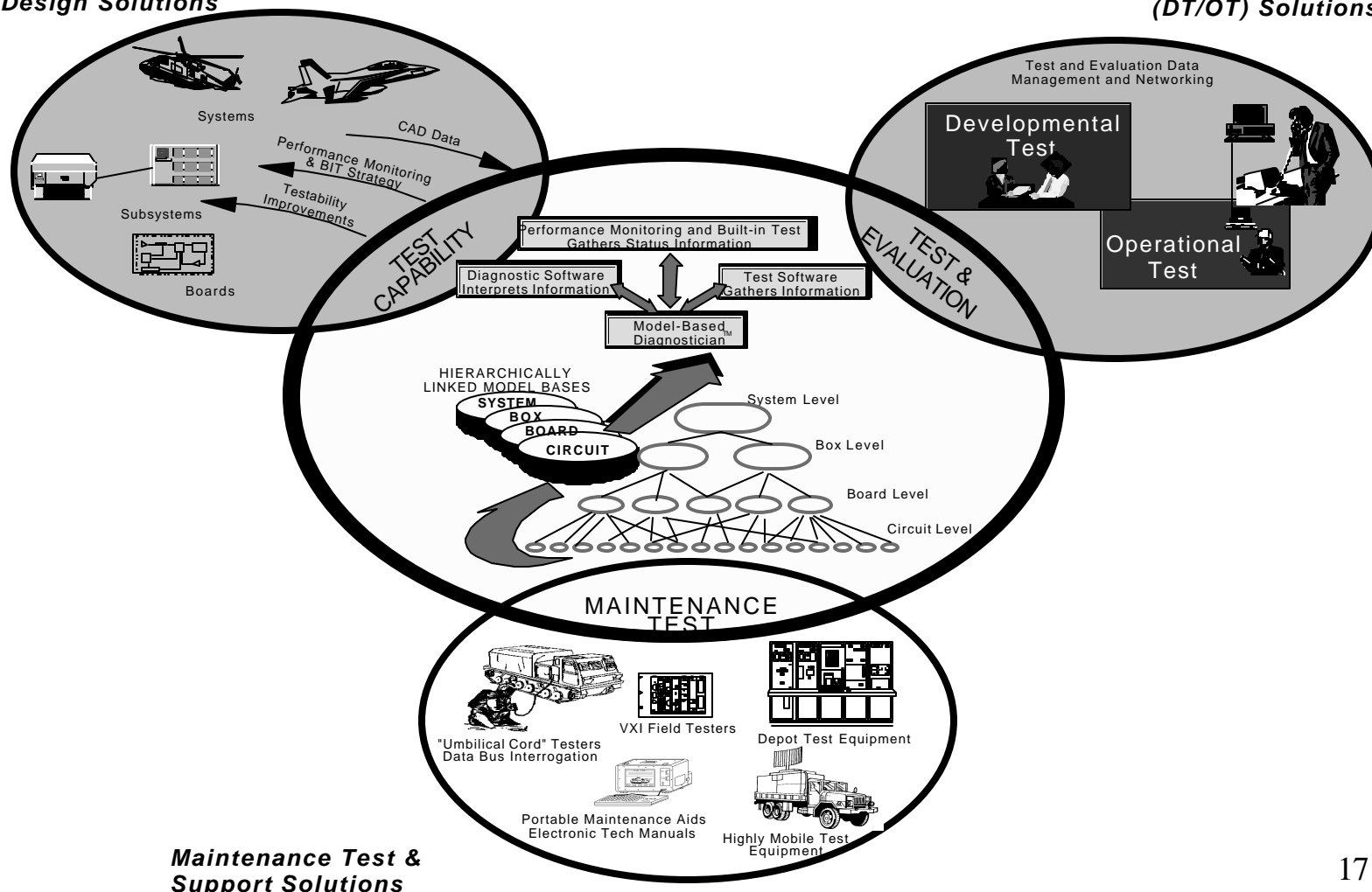Electronic Tech Manuals

Highly Mobile Test
Equipment

… and makes use of all T&E activities to mature this test, diagnostic and prognostic capability….

... to ensure that the fielded product meets its mission, performance, and supportability requirements.

Embedded Diagnostics Design Solutions

Test and Evaluation (DT/OT) Solutions

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TEST & EVALUATION

Test and Evaluation Data Management and Networking

Developmental Test

Operational Test

MAINTENANCE TEST

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Depot Test Equipment

Portable Maintenance Aids Electronic Tech Manuals

Highly Mobile Test Equipment

Maintenance Test & Support Solutions

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Today's technology supports this capability

Automated Reasoning using Model-Based Reasoning
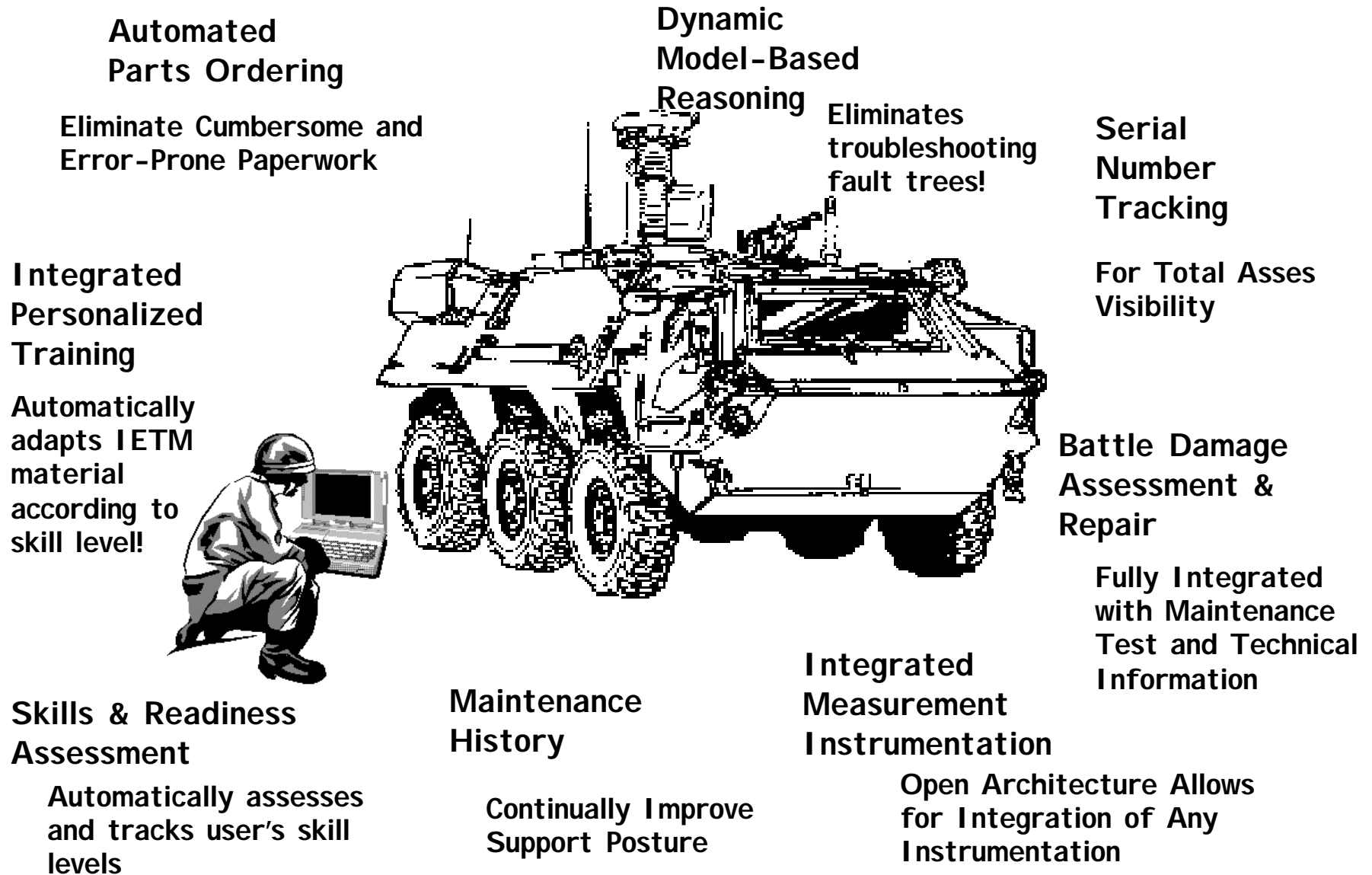
System Development

Diagnostic Profiler

Intelligent Diagnostics

✓ Model correlates all possible faults to all possible symptoms or test results

✓ Diagnostician provides fast, effective fault isolation in run-time.

✓ Combination results in *"Dynamic Diagnostics"*
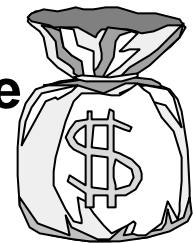
Diagnostician

Breaking the Wall Between Development and Maintenance

A Comprehensive Integrated Support Capability

Automated Parts Ordering

Eliminate Cumbersome and Error-Prone Paperwork

Dynamic Model-Based Reasoning

Eliminates troubleshooting fault trees!

Serial Number Tracking

For Total Asses Visibility

Integrated Personalized Training

Automatically adapts IETM material according to skill level!

Battle Damage Assessment & Repair

Fully Integrated with Maintenance Test and Technical Information

Skills & Readiness Assessment

Automatically assesses and tracks user's skill levels

Maintenance History

Continually Improve Support Posture

Integrated Measurement Instrumentation

Open Architecture Allows for Integration of Any Instrumentation

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COST SAVINGS

✓Test Program Set diagnostic flow charts replaced by Reasoner

    $$ 10 to 1 labor savings $$

✓Fault simulator reduced Verification and Validation costs

    $$ 50 to 1 labor savings $$

✓IETM troubleshooting procedures replaced by Reasoner

    $$ 10 to 1 labor savings $$

✓Embedded Diagnostics Reasoner replaced hard coded fault localization procedures & BIT Codes

    $$ 10 to 1 overall program savings $$

✓Training tool development cost and training cost will be reduced

THE BOTTOM LINE

ORDER OF MAGNITUDE DEVELOPMENT COST SAVINGS & MORE EFFECTIVE FIELDED CAPABILITY!!

MAINTENANCE TEST CHANGES FOCUS

NEW DIAGNOSTIC TECHNOLOGY REDUCES TEST REQUIREMENTS

➡ **UUT Fault Tree (Brute Force): Computer controlled test systems and simulated UUT operational environment to compare outputs and signals**

VS

➡ **Information-driven (Functional Analysis on design based data/information) -- Reduced test requirements, hierarchical models representing the UUT**

➡ **Design for both integrated diagnostics and prognostic/predictive management --** *INTEGRATED INFORMATION RESOURCES*

TECHNICAL APPROACH

❑ **Design for testing, integrated diagnostics, and prognostic/predictive management (Software Tools: Diagnostician and Prognostics Framework)**
  ➡ **Tie-in DT&E/OT&E with maintenance test requirement at development phase**

❑ **Maintenance Considerations**
  ➡ **Use design based data/information to develop embedded diagnostics/prognostics, or off-line test program sets (TPS) and develop the true interactive electronic technical manuals (IETMs)**
  ➡ **Develop *Integrated Information Resources***

TECHNICAL APPROACH (cont'ed)
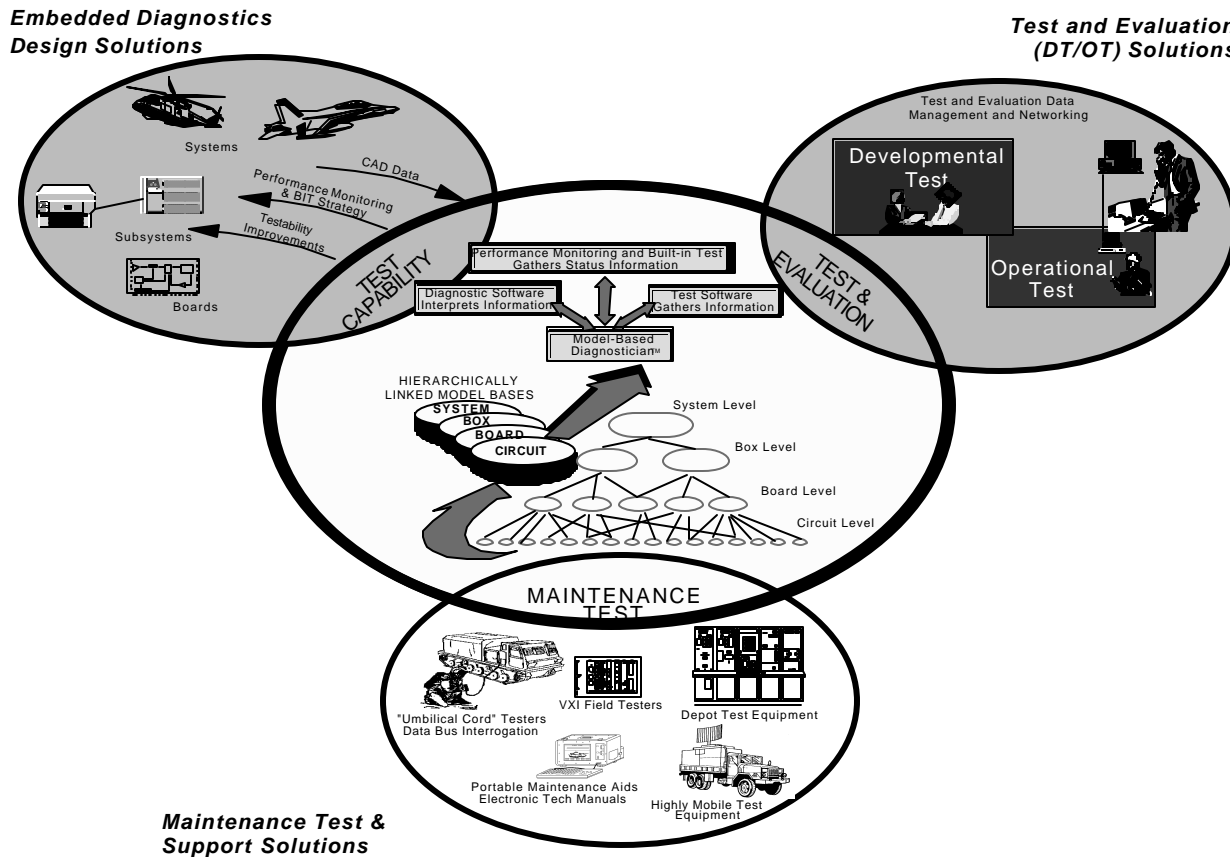
❑ **System Test and Evaluation**
- ➡ **Apply diagnostics and prognostics test for subsystems T&E**
- ➡ **Use simulations for T&E interfaces**
- ➡ **Use simulations for T&E launching interfaces**
- ➡ **Automate assessment and scorekeep the DT&E/OT&E performance tests**

❑ **System Battle Damage Assessment (BDA) and Repair Training**
- ➡ **Develop electronic BDA information (EBDAI)**
- ➡ **Integrate maintenance test information with field exercises, IETMs, and EBDAI for BDA repair training**

Combine DT&E and maintenance test data, diagnostic knowledge database, and BDAR information in development of an _integrated_ training to ensure

training _efficiency_, the fielded product meets its mission, performance, and supportability requirements.

Embedded Diagnostics Design Solutions

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Maintenance Test & Support Solutions

Training Implications

✓ Training Material Can Evolve and Mature with Diagnostics and Testing

✓ Training is improved by more realistic loading factors on the Logistics system

✓ Integrate Maintenance Training that *Adapts* to User Profile +Training then is an Integral Part of IETMs

✓ Training Range information imbedded into and onto Test Range information

✓ Training based upon Actual Maintenance Tasks as defined by Fault Population for Maintenance Test, T&E, BDAR, & WRM

RECOMMENDATIONS

White Paper call for
Formation of a TIGER TEAM

➡ Define what and how information and technology is to be leveraged
➡ Define the output products and requirements
➡ Provide funds to achieve
➡ Roadmap goals and schedules to achieve the goals

Provide integrated birth to battlefield information that supports the processes associated with what are NOW INDIVIDUAL STOVEPIPES

Combine T&E and Training, with the Maintenance test diagnostic knowledge database to provide an _integrated_ field training package for BDAR and enhance Logistics Supportability through Interoperability.
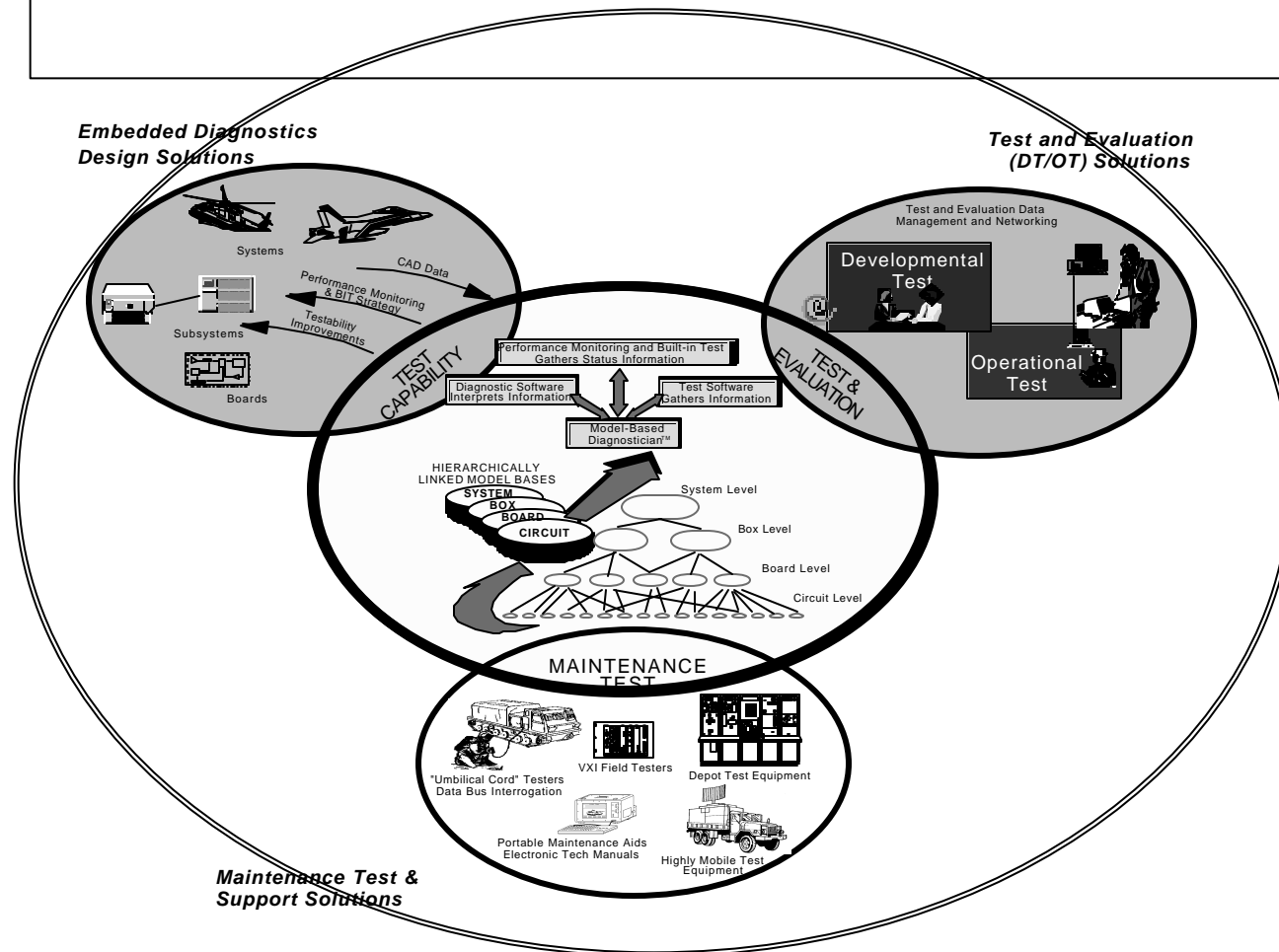
✓ _T&E_
✓ Training
✓ Logistics
   Supportability

A "BREAKTHROUGH" TECHNOLOGY
THAT CAN CHANGE THE FACE OF D/O
TEST EVALUATION & LOGISTICS SUPPORT
FOR COMPLEX MILITARY SYSTEMS

PREDICTIVE MAINTENANCE

AUTOMATED PARTS ORDERING

IETM/BDA TRAINING TOOL

TMDE | **TEST PROGRAM SETS**

IETM (INTERACTIVE ELECTRONIC TECHNICAL MANUAL) | **PORTABLE TEST/ MAINTENANCE AIDS**

EMBEDDED DIAGNOSTICS

TEST METHODS/DIAGNOSTICS LOGIC | **BIT/BITE/Sensor**

SYSTEM DESIGN FOR SUPPORTABILITY/DATABASE